

Quiz 2 (50 min) Name: _____ Student ID: _____

- (5 marks) Consider the vector $x = (1, 2, 0, 2)$. Find its mean, standard deviation, and root mean square. State the relationship between them.
- (15 marks) Consider the set of real n -vectors $x = (x_1, x_2, \dots, x_n)$, where n is an even number. The function $f(x)$ is defined as the average with odd indices, minus the average of the entries with even indices. Is $f(x)$ a linear function? If so, give its inner product representation, i.e., an n -vector a for which $f(x) = a^T x$ for all x . If not, give specific x, y, α, β for which superposition fails, i.e. $f(\alpha x + \beta y) \neq \alpha f(x) + \beta f(y)$.
- (15 marks) Suppose you want to rotate a vector $(4, 6)$ anti-clockwise by 30° . First, write down the rotation matrix. Then find the resultant vector after rotation.
- (20 marks) Find the best straight line fit (least squares) to the measurements
 $b = 4$ at $t = -2$, $b = 3$ at $t = -1$, $b = 1$ at $t = 0$, $b = 0$ at $t = 2$

5. (5 marks) Is the set of complex numbers under multiplication a group? Why or why not?
6. Consider the group $(G, \otimes)$, where G consists of all positive integers that are relative prime to 10 and $\otimes$ denote multiplication modulo 10.
- a) (5 marks) What are the elements in G ?
- b) (5 marks) Determine the identity and the inverses of all elements in G .
- c) (5 marks) Is $(G, \otimes)$ a cycle group? If so, determine all its generators. If not, explain why.
7. Consider the linear code which adds three parity bits c_3, c_4, c_5 to two information bits u_1, u_2 as follows: $c_3 = u_1, c_4 = u_1 + u_2, c_5 = u_2$.
- a) (7 marks) List all its codewords, determine its code rate and minimum distance, and state its error correction capability.
- b) (8 marks) Determine its generator matrix and parity check matrix,
- c) (10 marks) Suppose the vector $(1, 0, 0, 1, 0)$ is received. Compute the syndrome. Use the syndrome to identify the error bit, if any, Explain your reasoning.